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APPLICATION OF GEOSPATIAL TOOLS IN MORPHOMETRIC ANALYSIS AND PRIORITIZATION OF HIREHALLA WATERSHED, KOPPAL DISTRICT, KARNATAKA, INDIA

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Original Article

ABSTRACT

Morphometric evaluation and prioritization of twenty-five mini-watersheds of all Hirehalla watershed situated in Koppal district of Karnataka state, India had been completed with Remote Sensing (RS) and Geographic Information System (GIS) techniques. The morphometric parameters of considered analysis were flow order (Nu), flow length (Lu), bifurcation ratio (Rb), drainage density (Dd), flow frequency (Fs), feel ratio (T), type factor (Rf), cardiovascular ratio (Rc), elongation ratio (Re), duration of overland flow (Lg) and socket form (Bs). The watershed includes a dendritic drainage pattern. The Rb changes from 0.75 to 9.5 along with vast majority of those mini-watersheds fall under ordinary container category. In the current case Rc ranges from 0.18 to 0.79 suggesting that each of the mini-watersheds except 4D3A8A1, 4D3A8D2, 4D3A8M2, 4D3A8A2, 4D3A8B2, 4D3A8E1, 4D3A8H1, 4D3A8H2, 4D3A8I2, 4D3A8J2 and 4D3A8K2 are less or more elongated. The Re of all of the watersheds except 4D3A8C2, 4D3A8 F1, 4D3A8G2, 4D3A8H1, 4D3A8H2, 4D3A8N1 along with 4D3A8N2 is much less than 0.7 suggesting that the entire mini-watersheds are less or more elongated. The chemical parameter values were computed and prioritization evaluation of twenty-five mini-watersheds at Hirehalla watershed was completed. Even the mini-watershed 4D3A8A1, with maximum priority is much more likely to maximum dirt erosion risk.

KEYWORDS: Watershed, Remote Sensing, GIS, Morphometric Analysis & Mini-Watershed

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1. INTRODUCTION

The quantitative morphometric analysis of drainage system is an important aspect of characterization of watersheds [Strahler, 1964][1]. Drainage pattern identifies spatial relationship among rivers or streams, which could possibly be affected in their erosion from inequalities of slope, soils, stone immunity, construction and geological history of an area. Morphometry is your dimension and mathematical evaluation of this arrangement of the planet's surface, form and measurement of its landforms. This investigation can be accomplished through measurement of terminal, airborne and relief facets of this basin and incline contribution (Nag and Chakraborty, 2003 [2]). Integrated utilization of RS and GIS methods may be used for comprehensive morphometric evaluation and watershed prioritization research studies. The input parameters necessary for morphometric evaluation and watershed prioritization studies could be produced by GIS. Amee et al. [2007][3] employed a GIS process of morphometric evaluation and prioritization of watersheds. Al [2001][4] analyzed for priority watershed delineation together with the aim of choosing watersheds to tackle soil and water conservation steps using RS and GIS techniques. There have been radical changes in the hydrology of so lots of the arid regions of South India lately as a consequence of raised groundwater-based irrigation, watershed development and land use change. Though intensive development

of water sources has caused enormous advantages, its success has thrown up new challenges. In such regions, it's apparent that the emphasis must change from growth into the management of water sources to make sure that water has been allocated to actions with the greatest economic and societal price. In the current analysis, morphometric evaluation and prioritization of all 26 mini-watersheds of all Hirehalla watershed in Koppal District, Karnataka, India are completed with RS and GIS methods.

2. DESCRIPTION OF THE STUDY AREA

The analysis area is among those sub basins of Tungabhadra river basin at Karnataka, India. It's located in the southwestern portion of Koppal district covering elements of Gangavathi, Kustagi, (Sindhanur), Yelburga and Koppaltalukas at Karnataka. It is located between longitudes 760 9'11" along with 760 46' 5"E and latitudes 150 29' 38" along with twenty-five miniature watersheds draining into river Tungabhadra river in Koppal area of Karnataka. Study region has the highest altitude of 610 m and a minimal other principal streets. The average yearly rainfall in the analysis region is 584.6mm (Averaged More than 40 years). The place experiences a fever of 170° C Winter and a fever as large as 420° C. Heavy winds are dismissed during June to October period at a rate of approximately 30 kmph (IWMP report, 2010). The place map of this study region is shown in figure 1.

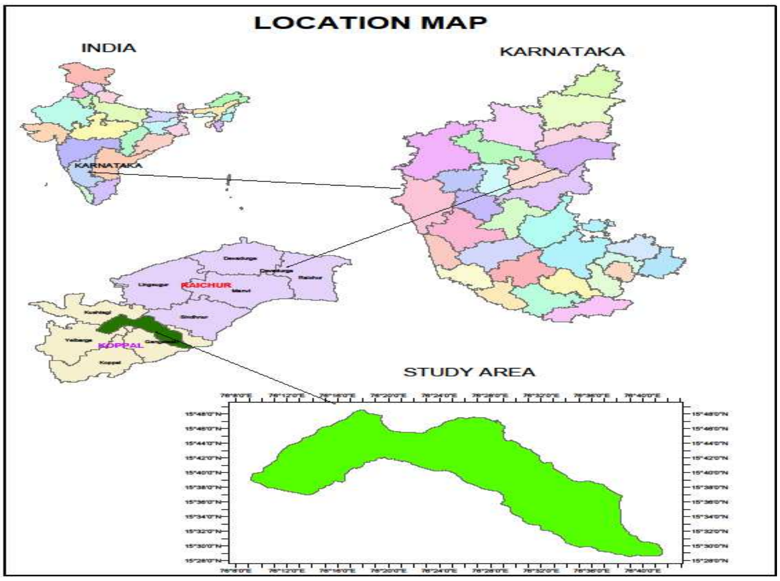

Figure 1: Location Map of Study Area.

3. METHODOLOGY

Survey of India (SOI) top maps, Indian Remote Sensing satellite data (CARTOSAT and LISS IV) and collateral data were used for the present study. The various SOI topographic maps used for the analysis of the study area that covered the Hirehalla catchment are SOI map **57A** on 1: 250000 scale and **56A/2, A/5, A/6, A/9, A/10 and A/11** on 1:50000 scale.

The digitization of drainage pattern was carried out in GIS environment. The stream ordering was carried out using the Strahler's law. The fundamental parameters namely; stream length, area, perimeter; number of streams and basin length were derived from the drainage layer.

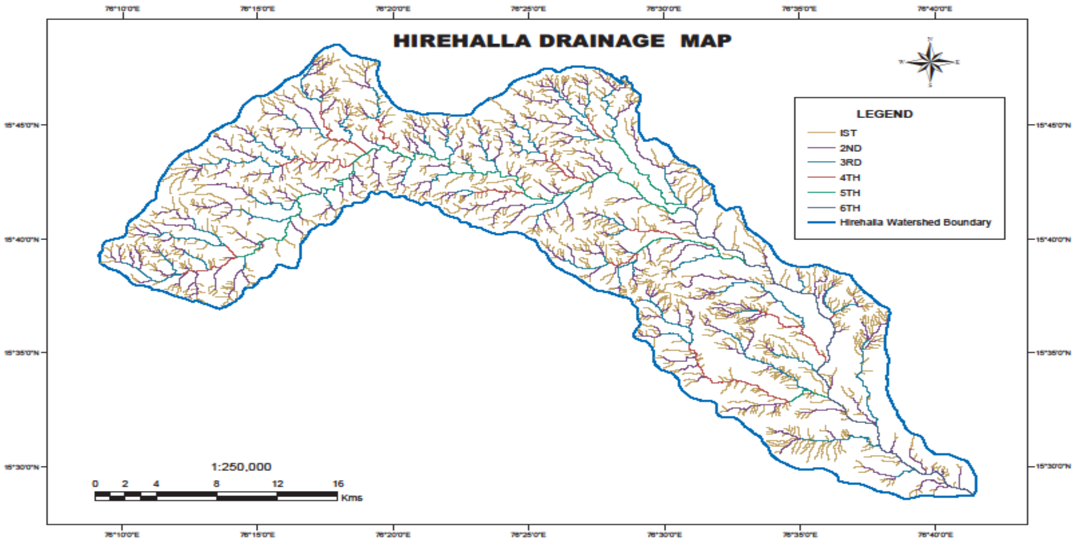

Figure 2: Drainage Pattern of the Study Area.

The morphometric parameters to get its delineated watershed region were computed based on several different formulae indicated by Horton [1945][5], respectively Strahler [1964][1], Hardly [1961][6], respectively Schumn [1956][7], respectively Nookaratanam et al. [2005][8] and Miller [1953][9] as stated in table 1. The morphometric parameters i.e., imply bifurcation ratio (Rbm), drainage density (Dd), imply flow length (Lsm), compactness coefficient (Cc), socket form (Bs), flow frequency (Fs), feel ratio (T) length of overland flow (Lg), type factor (Rf), circularity ratio (Rc) and elongation ratio (Re) are erosion hazard assessment parameters and also have been utilized for assigning mini-watersheds.

The inherent parameters like Dd, Fs, Rb, T, and Lg have an immediate connection with erodibility, greater the value, much more is erodibility. Hence, prioritization of all mini-watersheds, the maximum significance of linear parametershad been ranked as status 1, next greatest value was ranked as standing two and so forth, and also the least worth was rated in the position. Shape parameters like Re, Cc, Rc, Bs and Rf have a reverse connection with erodibility and [Akram Javed et al., 2009][10] reduced the value of the erodibility. Hence the smallest value of contour parameters was ranked as standing 1, alongside lower value was ranked as standing two and so forth and the maximum value was rated in the position. Therefore, the standing of this mini-watershed was decided by assigning the maximum priority/rank based on maximum value in the event of linearparameters and also lowest value in the event of contour parameters (Table 5). Following, the ranking was performed based on each and every parameter, the rank values forall of the linear and contour parameters of every mini-watersheds were added up to all those twenty six mini-watersheds to get there at chemical worth (Cp). According to typical value of those parameters, the mini-watersheds with the leastscore value have been assigned as the highest priority, so the next greater value was delegated moment priority and so forth.

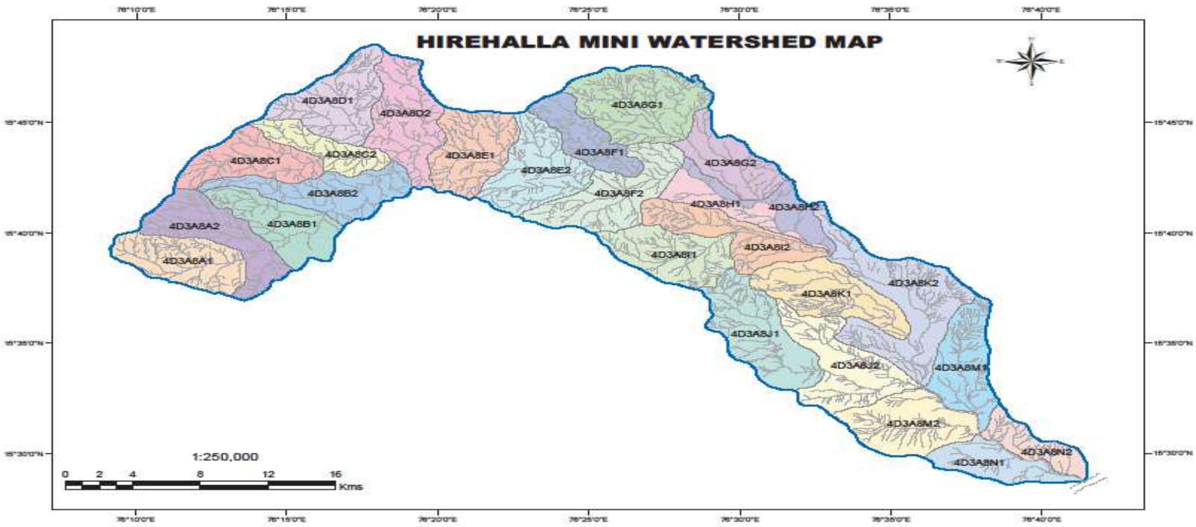

Figure 3: Miniwatershed Delineation of the Study Area.

Table 1: Formulae Utilized for Computation of Morphometric Parameters

SL.NO.	Morphometric parameters	Formulae	Reference
1	Stream Order (N_u)	Hierarchical rank	Strahler [1964][1]
2	Stream Length (L_u)	Length of the stream	Horton [1945][5]
3	Mean Stream Length (L_{sm})	$L_{sm} = L_u/N_u$	Strahler [1964] [1]
4	Bifurcation Ratio (R_b)	$Rb = N_u/N_{u+1}$	Schumn [1956][7]
5	Mean Bifurcation Ratio (R_{bm})	Rbm=Average of bifurcation ratio	Strahler [1964] [1]
6	Basin Length (L_b)	$Lb=1.312 X A^{0.568}$	Nookartnam et. al [2005]
7	Drainage Density (D_d)	$Dd=L_u/A$	Horton [1945][5]
8	Stream frequency (F_s)	$Fs= N_u/P$	Horton [1945][5]
9	DrainageTexture Ratio (T)	$T= N_u/P$	Horton [1945][5]
10	Form factor (R_f)	$Rf=A/L_b^2$	Horton [1945]][5]
11	Circularity Ratio (R_c)	$Rc=4\pi A/P^2$	Miller [1953] [9]
12	Elongation Ratio(R_e)	$Re=(2/Lb)X(A/\pi)^{0.5}$	Schumn [1956] [7]
13	Compactness Constant(C_c)	$Cc=0.2821 P/A^{0.5}$	Horton [1945][5]
14	Basin Shape (B_s)	$Bs=L_b^2/A$	Horton [1945][5]
15	Length of over Land flow (L_g)	$Lg=1/D_d*2$	Horton [1945][5]

Where, A = Area of the Basin (km^2), B_s = Form Factor, Cc = Compactness Ratio, D_d = Drainage density, L_b = Length of Basin (km), L_g=Length of overland flow, L_{sm} = mean Stream Length, L_u=Total Stream length of order u, N_u= Total number of stream segment of order u, Nu+1= Number of stream segment of next higher order, P=Perimeter (Km), R_b = Bifurcation Ratio, R_c= Circularity Ratio, R_e= Elongation Ratio.

4. RESULTS AND DISCUSSIONS

From the present analysis, morphometric evaluation ofthese parameters, specifically stream order, Flow length, bifurcation ratio, reliefratio, drainage density, Flow frequency, drainage Feel, form Variable, Cardiovascular ratio, elongation ratio, area, perimeter, length and width of All of the mini-watersheds was completed with the mathematical formulae provided from the table 1 and their results are summarized in tables 2–7.

Table 2: Mini Watershed Classification and their Distribution of Hirehalla Watershed

Sl. No.	Watershed Code	Name	Area(a) Km^2	Percentage of Total Area	Perimeter (p) Km
1	4D3A8A1	Nalagol	27.74	3.83	22.13
2	4D3A8A2	Mataldinni	29.83	4.12	31.00
3	4D3A8B1	Yeddoni	26.96	3.72	24.73
4	4D3A8B2	Sidlabhavi	28.57	3.94	32.97
5	4D3A8C1	Nagarhal	25.64	3.54	24.05
6	4D3A8C2	Guntanmadu	16.47	2.27	21.85
7	4D3A8D1	Hiremannur	30.96	4.27	26.14
8	4D3A8D2	Huliyapur	32.66	4.51	22.86
9	4D3A8E1	Hiremukarthal	28.72	3.96	31.14
10	4D3A8E2	Menadhal	31.91	4.41	26.22
11	4D3A8F1	Tawargeri	19.41	2.68	23.25
12	4D3A8F2	Sanganhal	33.13	4.57	31.51
13	4D3A8G1	Wirapur	41.26	5.70	27.48
14	4D3A8G2	Bukanhatti	22.79	3.15	23.56
15	4D3A8H1	Yetanhatti	13.60	1.88	28.75
16	4D3A8H2	Banhatti	14.06	1.94	31.55
17	4D3A8I1	Gudadur	28.36	3.92	24.36
18	4D3A8I2	Nauli	26.69	3.68	30.78
19	4D3A8J1	Wadki	36.74	5.07	29.19
20	4D3A8J2	ChikDanknal	33.98	4.69	33.31
21	4D3A8K1	Adapur	32.12	4.43	26.55
22	4D3A8K2	Hulkihal	50.61	6.99	49.78
23	4D3A8M1	Siddapur	27.5	3.80	27.56
24	4D3A8M2	Shriram Nagar	31.56	4.36	23.48
25	4D3A8N1	Kotankal	18.68	2.58	22.71
26	4D3A8N2	Kuntoji	14.42	1.99	20.60
		Total	**724.37**	**100**	**717.51**

4.1 Stream Order (N_u)

The flow ordering is your very first step towards septic tank investigation. It's founded on hierarchic standing of flows suggested by Strahler [1964][1]. The very first order flows don't have any tributaries. The next order flows have just original order streams as tributaries. In the same way, third order flows have second and first order streams as tributaries and so forth. The table 3 suggests the entire amount of 1750 flows were identified, of that 1373 are initial order flows, 284 are 2nd purchase, 35 are 3rd purchase, 16 are of 4th order, 14 are of 5th sequence and 3rd are of 6th purchase.

Table 3: Mini Watershed Stream Order Number Parameters

Watershed Code	Order-wise Total No. of Streams (N_u)						
	1st Order	2nd Order	3rd Order	4th Order	5th Order	6th Order	Total
4D3A8A1	78	21	04	01	--	--	104
4D3A8A2	19	02	--	--	--	1	22
4D3A8B1	34	06	01	--	01	--	42
4D3A8B2	44	12	03	--	01	--	60
4D3A8C1	45	08	02	01	--	--	56
4D3A8C2	36	07	01	01	--	--	45
4D3A8D1	67	12	03	01	--	--	83
4D3A8D2	64	11	04	02	01	--	82
4D3A8E1	66	18	04	--	01	--	89
4D3A8E2	80	13	04	01	01	--	99
4D3A8F1	53	13	02	01	--	--	69
4D3A8F2	53	13	01	01	01	--	69

4D3A8G1	104	20	05	01	01	--	131
4D3A8G2	20	04	01	---	01	--	26
4D3A8H1	11	22	--	--	01	1	35
4D3A8H2	11	02	--	--	02	1	16
4D3A8I1	64	15	04	01	01	--	85
4D3A8I2	48	11	01	01	01	--	62
4D3A8J1	68	16	03	01	--	--	88
4D3A8J2	82	13	02	01	01	--	99
4D3A8K1	67	12	03	01	--	--	83
4D3A8K2	108	15	04	01	--	1	129
4D3A8M1	60	06	01	--	--	1	68
4D3A8M2	54	06	01	--	--	1	62
4D3A8N1	19	02	--	--	--	1	22
4D3A8N2	18	04	01	--	--	1	24
Total	**1373**	**284**	**55**	**16**	**14**	**08**	**1750**

4.2 Stream Length (L_u)

It is the entire amount of flows in a specific purchase. The numbers of flows of numerous orders at a sub landmark were counted and their lengths were measured. Usually, the whole amount of stream segments falls with flow order. Deviation out of its overall behaviour in mini-watersheds 4D3A8A2,4D3A8B1, 4D3A8B2,4D3A8N2 indicate that the terrain will be characterised by high support or moderate to moderate slopes, underlain by changing lithology andProbable uplift throughout the basin [Singh and Singh 1997][11].

4.3 Bifurcation Ratio (R_b)

It is the ratio of the number of streams of a given order to the number of streams of the next higher order [Schumn, 1956][7]. Horton [1945][5] considered bifurcation ratio (R_b) as an index of relief and dissections. Strahler [1964][1] demonstrated that R_b shows only a small variation for different regions on different environment except, where powerful geological control dominates. Lower R_b values are the characteristics of structurally less disturbed watersheds without any distortion in drainage pattern [Nag, 1998][12]. The mean bifurcation ratio (R_{bm}) may be defined as the average of bifurcation ratios of all order (Table 6). In the present study, R_{bm} varies from 0.75 to 9.5 and all mini-watersheds fall under normal basin category.

Table 4: Miniwatershed Stream Order-wise Length Parameters

Watershed Code	Order-wise Total Length of Streams in Km(L_u)						
	1st Order	2nd Order	3rd Order	4th Order	5th Order	6th Order	Total
4D3A8A1	37.90	20.12	10.05	04.31	--	--	72.38
4D3A8A2	06.01	8.71	--	--	--	8.37	23.09
4D3A8B1	20.93	9.22	04.23		06.03	--	40.41
4D3A8B2	24.84	14.71	06.25	--	08.57	--	54.37
4D3A8C1	20.87	12.58	07.20	01.40	--	--	42.05
4D3A8C2	18.30	06.78	05.43	05.59	---	--	36.1
4D3A8D1	36.10	15.64	09.08	03.72	--	--	64.54
4D3A8D2	36.34	12.32	08.38	07.63	03.44	--	68.11
4D3A8E1	32.23	20.00	10.06	--	05.69	--	67.98
4D3A8E2	42.89	13.98	07.00	03.83	06.83	--	74.53
4D3A8F1	24.37	07.51	06.41	03.52	--	--	41.81
4D3A8F2	31.22	19.44	05.97	01.11	06.59	--	64.33
4D3A8G1	56.80	24.12	17.59	01.99	01.19	--	101.69
4D3A8G2	18.44	07.87	03.35	--	07.87	--	37.53

4D3A8H1	09.01	04.50	--	--	06.7	7.18	27.39
4D3A8H2	10.19	02.23	--	--	06.99	7.18	26.59
4D3A8I1	39.97	14.28	09.22	02.93	02.02	--	68.42
4D3A8I2	27.30	10.29	07.70	04.00	06.56	--	55.85
4D3A8J1	42.28	16.17	08.66	05.58	--	--	72.69
4D3A8J2	44.42	12.37	08.62	04.94	03.38	--	73.73
4D3A8K1	42.20	18.27	11.22	06.95	--	--	78.64
4D3A8K2	62.81	12.12	10.25	03.74	--	15.88	104.8
4D3A8M1	20.48	09.42	08.18	--	--	6.09	44.17
4D3A8M2	40.78	11.18	06.36	--	--	6.09	64.41
4D3A8N1	06.01	08.71	--	--	--	8.38	23.1
4D3A8N2	11.62	07.10	01.54	---	--	8.38	28.64
Total	**772.31**	**319.6**	**172.7**	**61.24**	**71.86**	**59.18**	**1456.89**

4.4. Mean Stream Length (L_{sm})

The mean stream length of a channel is a dimensional property and reveals the characteristic size of drainage network components and its contributing basin surfaces [Strahler, 1964][1]. The mean stream length (L_{sm}) has been calculated by dividing the total stream length of order by the number of streams. Table 4 indicates that L_{sm} in these mini-watersheds ranges from 7.03 to19.77 km. It is observed that L_{sm} values of all the mini-watersheds indicate that L_{sm} of the given order is greater than that of the lower order and less than that of the next order, except in case of 4D3A8G1, 4D3A8H1, 4D3A8I1, 4D3A8I2, 4D3A8J2 and 4D3A8N2 there is a deviation from this general observation. This deviation might be due to variation in slope and topography.

Table 5: Mean Stream Length of Hirehalla Mini-Watersheds

Watershed Code	Mean Stream Length of Streams (L_{sm})						
	1st Order	2nd Order	3rd Order	4th Order	5th Order	6th Order	Total
4D3A8A1	0.49	0.96	2.51	4.31	--	--	8.27
4D3A8A2	0.32	4.36	---	--	--	8.37	13.05
4D3A8B1	0.62	1.54	4.23	--	6.03	--	12.42
4D3A8B2	0.56	1.23	2.08	--	8.57	--	12.44
4D3A8C1	0.46	1.57	3.60	1.40	--	--	7.03
4D3A8C2	0.51	0.97	5.43	5.59	--	--	12.5
4D3A8D1	0.54	1.30	3.03	3.72	--	--	8.59
4D3A8D2	0.57	1.12	2.10	3.82	3.44	--	11.05
4D3A8E1	0.49	1.11	2.52	--	5.69	--	9.81
4D3A8E2	0.54	1.08	1.75	3.83	6.83	--	14.03
4D3A8F1	0.46	0.58	3.20	3.52	--	--	7.76
4D3A8F2	0.59	1.50	5.97	1.11	6.59	--	15.76
4D3A8G1	0.55	1.21	3.52	1.99	1.19	--	8.46
4D3A8G2	0.92	1.97	3.35	--	7.87	--	14.11
4D3A8H1	0.82	0.20	--	--	6.70	7.18	14.9
4D3A8H2	0.93	1.12	--	--	3.50	7.18	12.73
4D3A8I1	0.63	0.95	2.31	2.93	2.02	--	8.84
4D3A8I2	0.57	0.94	7.70	4.00	6.56	--	19.77
4D3A8J1	0.62	1.01	2.89	5.58	--	--	10.1
4D3A8J2	0.54	0.95	4.31	4.94	3.38	--	14.12
4D3A8K1	0.60	1.52	3.74	6.95	--	--	12.81
4D3A8K2	0.59	0.80	2.56	3.74	--	15.88	23.57
4D3A8M1	0.34	1.57	8.18	--	--	6.09	16.18
4D3A8M2	0.76	1.86	6.36	--	--	6.09	15.07
4D3A8N1	0.32	4.35	---	--	---	8.38	13.05
4D3A8N2	0.65	1.78	1.54	--	--	8.38	12.35
Total	**15.17**	**37.55**	**82.82**	**57.43**	**68.37**	**67.55**	**328.95**

4.5 Drainage Density (D_d)

Horton [1932][13] introduced the drainage amount (Dd) is a significant index of the inherent scale of land-form components in flow eroded topography. It's the proportion of overall channel section spans cumulated for the majority of orders inside a container into the basin region, which can be expressed concerning km/km^2. The drainage density suggests that the proximity of spacing of stations, thusgiving a quantifiable measure of the ordinary period of flow channel for the entire basin. High nitrate density is the end result of poor or impermeablesubsurface substance, sparse vegetation and unexpected relief. Low drainage density contributes to class drainage feel whereas high drainage density results in good drainage feel [Strahler, 1964][1]. The drainage density (Dd) of this research region is changeable between 0.77and also 2.61 km/km^2 signaling low drainage densities.

Table 6: Shape Parameters of Hirehallamini-Watersheds

Watershed Code	Shape Parameters				
	Shape Factor(B_s)	Form Factor(R_f)	Circulatory Ratio(R_c)	Compactness Co-efficient(C_c)	Elongation Ratio(R_e)
4D3A8A1	2.70	0.37	0.71	1.19	0.69
4D3A8A2	2.73	0.36	0.39	1.60	0.68
4D3A8B1	2.69	0.37	0.55	1.34	0.69
4D3A8B2	2.71	0.36	0.33	1.74	0.69
4D3A8C1	2.67	0.37	0.56	1.34	0.69
4D3A8C2	2.52	0.39	0.43	1.52	0.71
4D3A8D1	2.74	0.36	0.57	1.33	0.68
4D3A8D2	2.76	0.36	0.79	1.13	0.68
4D3A8E1	2.71	0.36	0.37	1.64	0.68
4D3A8E2	2.75	0.36	0.58	1.31	0.68
4D3A8F1	2.58	0.38	0.45	1.49	0.70
4D3A8F2	2.77	0.36	0.42	1.54	0.68
4D3A8G1	2.85	0.35	0.69	1.21	0.67
4D3A8G2	2.63	0.38	0.52	1.29	0.70
4D3A8H1	2.46	0.40	0.21	2.20	0.72
4D3A8H2	2.46	0.40	0.18	2.37	0.72
4D3A8I1	2.71	0.37	0.60	1.36	0.68
4D3A8I2	2.69	0.37	0.35	1.68	0.68
4D3A8J1	2.81	0.35	0.54	1.36	0.67
4D3A8J2	2.78	0.35	0.38	1.61	0.68
4D3A8K1	2.76	0.36	0.57	1.32	0.68
4D3A8K2	2.93	0.34	0.26	1.97	0.66
4D3A8M1	2.70	0.37	0.45	1.48	0.69
4D3A8M2	2.75	0.36	0.79	1.18	0.68
4D3A8N1	2.56	0.39	0.46	1.48	0.71
4D3A8N2	2.47	0.40	0.43	1.53	0.72

4.6 Stream Frequency (F_s)

Stream frequency/channel frequency (Fs) will be that the entire amount of flow segments of orders each unit area [Horton, 1932][13]. Hypothetically, it's possible to possess the basin of drainage density diverse in flow frequency and pouch of same flow frequency diverse from drainage density. Table 7 reveals Fs for many mini-watersheds of this study region. It's mentioned that the Fs demonstrates positive correlation with all the drainagevalues of this mini-watersheds signaling the gain in flow population in regard to raise in nitrate density.

4.7 Texture Ratio (T)

It's the entire amount of flow segment of orders each perimeter of the region [Horton, 1945][5]. Horton recognized infiltration capability since the only important element that affects drainage feel (T) and believed that the T to comprise D_d and F_s. Smith[1950][14] has categorized drainage density to five distinct feel i.e. quite primitive (<2), Coarse (2–4), medium (4–6), nice (6–8)and quite nice (>8). In the current study, all of the sub watersheds have quite coarse drainage feel because of their drainage densitiesrange from 0.71 to 4.77. The decreased values of feel ratio demonstrate that thebowl is plain with lesser amount of slopes.

Table 7: Linear Morphometric Parameters of the Mini-Watersheds

Watershed Code	Linear Parameters				
	Drainage Density(D_d)	Stream Frequency(F_s)	Bifurcation Ratio(R_b)	Drainage Texture(T)	Overland Flow Length(L_g)
4D3A8A1	2.61	3.75	4.32	4.70	0.19
4D3A8A2	0.77	0.74	9.50	0.71	0.65
4D3A8B1	1.50	1.56	5.84	1.70	0.33
4D3A8B2	1.90	2.10	3.84	1.82	0.26
4D3A8C1	1.64	2.18	3.88	2.33	0.30
4D3A8C2	2.19	2.73	4.38	2.06	0.23
4D3A8D1	2.08	2.68	4.19	3.18	0.24
4D3A8D2	2.09	2.51	3.14	3.59	0.24
4D3A8E1	2.37	2.73	4.00	2.86	0.21
4D3A8E2	2.34	3.10	3.60	3.78	0.21
4D3A8F1	2.15	3.55	4.58	2.97	0.23
4D3A8F2	1.94	2.08	6.02	2.19	0.26
4D3A8G1	2.46	3.17	4.73	4.77	0.20
4D3A8G2	1.65	1.85	4.50	1.10	0.30
4D3A8H1	1.95	2.49	0.75	1.22	0.26
4D3A8H2	1.89	1.14	3.75	0.51	0.26
4D3A8I1	2.41	3.00	3.23	3.49	0.21
4D3A8I2	2.09	0.43	4.30	2.01	0.24
4D3A8J1	1.98	2.40	4.19	3.01	0.25
4D3A8J2	2.17	2.91	3.95	2.97	0.23
4D3A8K1	2.45	2.58	4.19	3.13	0.20
4D3A8K2	2.07	2.55	4.98	2.59	0.24
4D3A8M1	1.61	2.47	8.00	2.47	0.31
4D3A8M2	2.04	1.96	7.50	2.64	0.25
4D3A8N1	1.24	1.18	9.50	0.97	0.40
4D3A8N2	1.99	1.66	4.25	1.17	0.25

4.8 Form Factor (R_f)

It's described as the proportion of basin region to square of this container span [Horton,1932][13]. The worth of Rf would constantly be 0.7854 (to get a totally curved basin). Smaller the significance of shape factor, more extended is the basin. The basins with higher shape variables have elevated peak flows of briefer length, whereas, even elongated min-watershed with reduced shape variables havereduced peak speed of longer period. It's noted that the Rf values range from0.34 to 0.40. It indicates they have elongated shape and flatter peakflow for longer length.

4.9 Circulatory Ratio (R_c)

Circulatory ratio is ratio of the area of the basin to the area of circle having the same circumference as the perimeter of the basin [Miller, 1953][9]. It is influenced by the length and frequency of streams, geological structures, land use/land cover,

climate, relief and slope of the basin. In the present case R_c ranges from 0.18 to 0.79 indicating that all the mini-watersheds except 4D3A8A1, D2, M2 4D3A8A2, B2, E1, H1, H2, I2, J2 and K2 are more or less elongated. Miller et al. [1953][9] has described the basin of the circularity ratios range 0.4 to 0.7, which indicates strongly elongated and highly permeable homogenous geologic materials.

4.10 Elongation Ratio (R_e)

It's the ratio between the width of the ring of the exact same place since theseptic tank as well as also the maximum length of this basin. A round basin is significantly more effective in run-off release compared to a noodle noodle [Singh and Singh, 1997][15]. The worth of elongation ratio (Re) normally changes from 0.6 to 1.0correlated with a huge array of climate and geology. Values close to 1.0 areaverage of areas of very low aid whereas the of 0.6 to 0.8 are related to higher relief and steep earth incline [Strahler, 1964][1]. These principles may be categorized into three classes, namely circular (>0.9), oval (09-0.8) and elongated (<0.7). Elongation ratios of all of the water sheds are at the scope 0.68-0.72 suggesting thateach one of the mini-watersheds are all elongated.

4.11 Length of Overland Flow (L_g)

Length of overland flow is the duration of water on the earth before it has concentrated into certain flow stations, [Horton, 1945][5]. This variable changes inversely proportional to the normal slope of the station and is very interchangeable with the duration of sheet flow into a massive level. It roughly equals half reciprocal of drainage [Horton, 1945][5]. Table 7 shows that the calculated value of Lg for allmini-watersheds changes from 0.19 and 0.65. The worth of Lg is greater in the event of 4D3A8A1 indicatingreduced aid, whereas the worth of Lg is reduced in the event of 4D3A8A2 indicatinghigh aid.

4.12 Basin Shape (B_s)

Basin shape is the ratio of the square of basin length (L_b) to the area of the basin (A). The B_s values of mini-watersheds varies between 2.46 and 2.95

4.13 Prioritization of Mini-watersheds

The compound parameter values of 26 mini-watersheds of all Hirehalla basin were calculated and prioritization rating is shown in table 8. Watershed 4D3A8A1 with a chemical parameter significance of 7.2 receives the maximum priority (just one) with last from the priority list is watershed 4D3A8H2 with the compound parameter significance of 13.5. Maximum priority suggests the greater amount of erosion in theparticular min-watershed also it will become potential area for implementing soil conservative measure. The last prioritized map of the study area is shown at figure 4. Thus soil conservation measures can be employed to min-watershed 4D3A8A1region and then to the other mini-watersheds based upon their priority.

Table 8: Priority Computation of Hirehalla Mini-Watersheds

Mini-Watershed Code	Linear Parameters					Shape Parameters					Compound Value (Cp)	Priority Rank	Final Priority
	D_d	F_s	R_b	T	L_g	R_f	B_s	R_c	C_c	R_c			
4D3A8A1	1	1	11	2	13	4	9	24	3	4	7.2	1	HIGH
4D3A8A2	26	23	15	25	1	3	11	8	16	3	13.1	21	LOW
4D3A8B1	24	22	14	20	3	4	8	17	9	4	12.5	19	LOW
4D3A8B2	19	17	14	19	6	3	10	4	20	4	11.6	14	MEDIUM
4D3A8C1	22	16	19	15	5	4	7	18	9	4	11.9	16	LOW
4D3A8C2	7	7	9	17	10	6	3	10	13	6	8.8	5	HIGH

4D3A8D1	12	9	12	6	8	3	12	19	8	3	9.2	6	HIGH
4D3A8D2	10	12	13	4	8	3	14	25	1	3	9.3	7	HIGH
4D3A8E1	5	8	18	11	11	3	10	6	18	3	9.3	7	HIGH
4D3A8E2	6	4	7	3	11	3	13	21	6	3	7.7	2	HIGH
4D3A8F1	9	2	8	9	10	5	5	12	12	5	7.7	2	HIGH
4D3A8F2	18	18	1	16	6	3	15	9	15	3	10.4	12	MEDIUM
4D3A8G1	2	3	5	1	12	2	18	23	4	2	7.2	1	HIGH
4D3A8G2	21	20	16	23	5	5	6	15	5	5	12.1	17	MEDIUM
4D3A8H1	17	13	21	21	6	7	1	2	22	7	11.7	15	MEDIUM
4D3A8H2	20	24	20	26	6	7	1	1	23	7	13.5	22	LOW
4D3A8I1	4	5	10	5	11	4	10	22	10	3	8.4	4	HIGH
4D3A8I2	11	26	2	18	9	4	8	5	19	3	10.5	13	MEDIUM
4D3A8J1	16	15	12	8	7	2	17	16	10	2	10.5	13	MEDIUM
4D3A8J2	8	6	4	10	10	2	16	7	17	3	8.3	3	HIGH
4D3A8K1	3	10	16	7	12	3	14	20	7	3	9.5	8	MEDIUM
4D3A8K2	13	11	6	13	9	1	19	3	21	1	9.7	9	MEDIUM
4D3A8M1	23	14	3	14	4	4	9	13	11	4	9.9	10	MEDIUM
4D3A8M2	14	19	3	12	7	3	13	26	2	3	10.2	11	MEDIUM
4D3A8N1	25	23	11	24	2	6	4	14	11	6	12.6	20	LOW
4D3A8N2	15	21	17	22	7	7	2	11	14	7	12.3	18	LOW

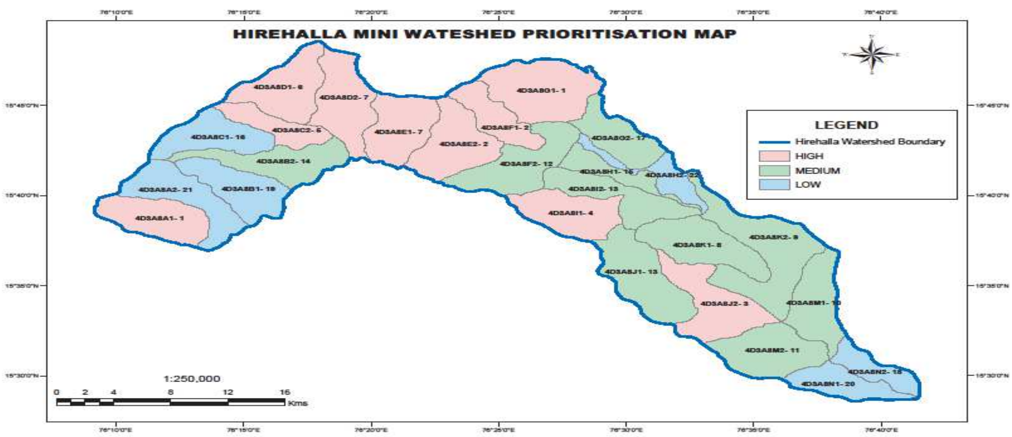

Figure 4: Prioratisation of Hirehalla Mini Watershed.

5. CONCLUSIONS

The current study shows the usefulness of remote sensing and GIS methods in prioritising mini-watersheds according to morphometric evaluation. Each of the mini-watersheds reveals dendritic to sub dendritic drainage pattern having rough drainage feel. The very low bifurcation ratios suggest ordinary container category. The minimal drainage density suggests that the pouch is extremely permeable subsoil, thick plant cover, very low relief and path drainage feel. What's more, the remote sensing methods are proven to be acceptable for thepreparation of upgraded drainage map at a timely and cheap fashion andought to be chosen in soil erosion research for deriving input information. The outcomes of morphometric analysis reveal that mini-watershed 4D3A8A1 is potentially having high erosion hazard. Therefore, proper soil erosion management measures are needed within this watershed tomaintain the property from further erosion based on priority basis.

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